TITLE OF THE INVENTION
HOT-AIR HEATER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a hot-air heater in which an electric heater is incorporated along an air-blowing passage.

2. Description of the Related Art

A conventional hot-air heater, as described in Jpn. Pat. Appln. KOKAI Publication No. 1998-132385, comprises a frame having an outlet and an inlet formed therein. An air-blowing passage is formed in the frame that leads from the inlet to the outlet. This air-blowing passage is provided with an air-blowing fan on the upstream side and an electric heater, constituting an elongated sheathed heater etc. on the downstream side. In this case, the electric heater is positioned in such a manner that it intersects with the air flowing along the air-blowing passage. In this configuration, if the air-blowing fan is operated, air is sucked into the air-blowing passage through the inlet and heated by the electric heater to provide hot air having a predetermined temperature, which is blasted out of the outlet into a room.

However, in the heater described in the above publication, the air trunk area of the air-blowing passage is kept constant all along this passage leading from the downstream side of the air-blowing fan to the outlet, and the electric heater is provided somewhere along this passage to provide air trunk resistance in this air-blowing passage (i.e., resistance against air flow in the air-blowing passage). Therefore, to provide sufficient airflow to the hot air to be blasted out of the outlet, it is necessary to increase the rotation speed of the air-blowing fan; however, this increases the operating sound, which, in turn, poses a problem. In this case, to decrease the air trunk resistance, increasing the cross-sectional area of the air-blowing passage may be considered (hereinafter referred to as air trunk area); however, this increases the size of the relevant appliance and decreases the wind speed, which, in turn, poses a problem.

In view of the above, the object of the present invention is to provide a hot-air heater in which the air trunk resistance, when an electric heater is provided along an air-blowing passage, does not increase, which thereby ensures that the wind speed at the outlet may not decrease.

SUMMARY OF THE INVENTION

To solve the above problems, according to the present invention, a hot-air heater comprises:

(a) an air-blowing passage leading from an inlet to an outlet;

(b) an air-blowing fan and an electric heater that are provided along the air-blowing passage, so that when the air-blowing fan is operated to suck air into the air-blowing passage through the inlet, the air is heated by the electric heater to provide hot air, which is blasted out of the outlet into a room,

wherein an expansion is formed along the air-blowing passage as a storage portion to contain the electric heater.

According to the present invention, when the air-blowing fan is operated, air is sucked into an air passage and thus reaches the electric heater. In this case, the air trunk area of the storage portion, in which the electric heater is contained, has been increased so that the air-blowing resistance in this portion does not increase and can, therefore, be made nearly equal to the air-blowing resistance of the air-blowing passage in front of and behind this storage portion. Therefore, the air flows through the air-blowing passage smoothly and the rotation speed of the air-blowing fan does not need to be increased.

In this case, if the air trunk area on the downstream side of said expansion is decreased smoothly, the occurrence of turbulent flow can be prevented and thus the resistance of air flowing along an inner surface of the expansion can be decreased, which will, thereby, further decrease the air trunk resistance.

Further, if the cross-sectional area of the exit and inlet of said expansion are increased compared to that of the entrance of this expansion, then the air trunk can be decreased further.

In case said air-blowing passage has a bent portion formed halfway through it, said air-blowing fan is equipped with a moving vane positioned at the bent portion. Furthermore, the electric heater is positioned at the expansion, that is, on the downstream side of this bent portion, in such a manner that it intersects with the air-blowing passage. Thus, the volume of air flowing through the inner side of the bent portion decreases compared to that flowing through its outer side; therefore, the air-blowing passage positioned on the inner side of the bent portion is overheated by radiation heat etc. from the electric heater, increasing the risk of the appliance itself getting overheated by the excess

radiation heat etc. Therefore, preferably, the space between the inner wall of the expansion positioned on the inner side of the expansion and the electric heater is increased compared to the space between the inner wall of the expansion positioned on the outer side of the bent portion and the electric heater. This not only ensures smooth air flow but also prevents the overheating of the appliance.

Further, it is possible to prevent the overheating of the appliance, which is influenced by the expansion of the electric heater, even if this expansion is overheated by providing heat insulation means around the expansion of said electric heater.

Furthermore, if said expansion has a double structure, comprising the inner and outer walls of the air-blowing passage and the airspace between them, then this structure can decrease thermal conductivity, thereby improving the heat insulation effects.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an explanatory plan view of the configuration of a hot-air heater according to the present invention;

FIG. 2 is an explanatory enlarged cross-sectional view of a part of the air-blowing passage of a conventional embodiment;

FIG. 3 is an explanatory enlarged cross-sectional view of a part of the air-blowing passage of the present invention;

FIG. 4 is an explanatory enlarged cross-sectional view of a part of the air-blowing passage of a variant;

FIG. 5 is an explanatory enlarged cross-sectional view of a part of an air-blowing passage of a variant;

FIG. 6 is an explanatory enlarged cross-sectional view of a part of an air-blowing passage of a variant;

FIG. 7 is an explanatory enlarged cross-sectional view of a part of an air-blowing passage of a variant;

FIG. 8 is an explanatory enlarged cross-sectional view of a part of an air-blowing passage of a variant; and

FIG. 9 is an explanatory enlarged cross-sectional view of part of an air-blowing passage of a variant.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

In FIG. 1, the reference numeral 1 indicates a hybrid-type hot-air heater according to the present invention. This hot-air heater 1 has a box-shaped frame 11, which , incorporates a gas heater portion 2 on the top and an electric heater portion 3 at the bottom. A first outlet 12a and a second outlet 12b are formed at the front face of frame 11 and a first inlet 13a and a second inlet 13b are formed at the rear face of frame 11 to face the gas heater portion 2 and the electric heater 3, respectively. This arrangement ensures that the two air-blowing fans used to make the air-blowing system of the gas heater portion 2 and that of the electric heater portion 3 are independent of each other.

The gas heater portion 2 constitutes a gas burner 20 and a first air-blowing fan 21, which is arranged below the gas burner 20. The gas heater portion 2 not only supplies the gas burner 20 with combustion air, but also mixes the combustion gas with air sucked through the first inlet 13a in the frame 11 to blast them out into a room. The gas burner 20 has a burner body 20a, which has a fuel/air inlet 201 with a gas spray nozzle (not shown) mounted to the a tip of a gas tube that is connected to a proportional valve (not shown) arranged in the frame 11 and a mixer tube portion 202 that communicates with this inlet 201. A ceramic flame-port plate 203 having a plurality of flame ports provided thereon in a row is mounted on the upper open face of the burner body 20a via a distribution plate (not shown), so that the gas burner 20 is contained in the combustion chamber 204.

The frame 11 contains a diversion plate 41 in such a manner that it surrounds the upper portion of the combustion chamber 204. This ensures that when the first air-blowing fan 21 is operated, air sucked through the first inlet 13a in the frame 11 and combustion gas discharged from the combustion chamber 204 can be partitioned from each other until they flow at a predetermined distance. Further, the frame 11 also contains a partition 43 in such a manner that it covers combustion chamber 204 including the diversion plate 41 and forms an air passage 42 to lead to the first air-blowing fan 21 between itself and the diversion plate 41. The air-blowing fan 21 positioned below the burner body 20a has a housing 211 in which an air-blowing duct 211a leading to the first outlet 12a is formed.

In the housing 211 a cross-flow type first moving vane 212 is arranged, which is connected to a first motor (not shown) whose rotation speed can be controlled. In this case, the air passage 42 and the internal space of the housing 211 communicate with each other through an upper-face opening 213 in the housing 211. In such a manner, an air-blowing system of the gas heater portion 2 leading from the first inlet 13a to the first outlet 12a is formed. In this configuration, when the first motor is driven to rotate the first moving vane

212, air in the room is sucked through the inlet 13a in the frame 11 so that it can be supplied to the inlet 201 in the burner body 20a and then flow through the air passage 42.

In this case, if fuel gas is sprayed through a gas spray nozzle (not shown) to the inlet 201, an air-fuel mixture is supplied to the flame port plate 203 and then burns. It should be noted that the air/fuel ratio is adjusted by controlling the first motor, to control the rotation speed of the first moving vane 212. Combustion gas generated from the gas burner 20 as a result of the burning of the air-fuel mixture passes through a combustion gas passage 44 on an inner side of the diversion plate 41 and is sucked toward the first air-blowing fan 21. On arriving at the downstream end of the diversion plate 41, the combustion gas and the air are mixed to be cooled and flow through the opening 213 in the housing 211. Then, the air-fuel mixture having a predetermined temperature is released through the first outlet 12a into the room.

On the other hand, the electric heater portion 3 is contained in a case 31 made of resin and has an air-blowing passage 32 leading from the second inlet 13b to the second outlet 12b. In this case, to miniaturize the electric heater portion 3, the air-blowing passage 32 is bent in a direction from the upper side of the appliance 1 to the horizontal side. The bent portion 32a obtained by thus bending this air-blowing passage 32 is provided with a second air-blowing fan 33. The second air-blowing fan 33 constitutes a second motor (not shown), whose rotation speed can be controlled, and a roughly cylindrical cross-flow type second moving vane 331, which is connected to this second motor and arranged on the bent portion 32a. The downstream side of this bent portion 32a is provided with an electric heater 34. It should be noted that the control of the rotation speed of the second motor does not influence the functioning of said electric heater 34.

The electric heater 34 has a configuration in which a combination of elongated sheathed heaters 341, which are arranged in three vertical stages with a predetermined space in between in such a manner that they intersect with the air-blowing passage 32, are aligned in as many as three rows in the airflow direction so that the sheathed heaters 341 may alternate with each other. Each sheathed heater 341 is supported by the frame 11 via a holder (not shown). In such a manner, an air-blowing system of the electric heater portion 3 is formed so as to lead from the second inlet 13b to the second outlet 12b. Then, if the second air-blowing fan 33 is operated, air is sucked through the second inlet 13b in the air-blowing passage 32 and heated by the electric heater 34 to provide hot air, which is blasted out of the second outlet 12b into the room. The hot air, when blasted out of this second outlet 12b, may

possibly overheat the floor of the room. Therefore, a lower face 321 of the air-blowing passage 32 leading from the second air-blowing fan 33 to the second outlet 12b is formed to incline upward.

In this configuration, if, as shown in FIG. 2, the air trunk area of the air-blowing passage 32 is kept constant all along this passage leading from the downstream side of the air-blowing fan 33 to the second outlet 12b and the electric heater 34 is mounted somewhere along this passage, the electric heater 34 itself provides air trunk resistance in this air-blowing passage 32. Therefore, to provide sufficient airflow to the hot air to be blasted out of the second outlet 12b, it is necessary to increase the rotation speed of the second air-blowing fan 33, which, in turn, increases the operating sound and poses a problem. In this case, increasing the cross-sectional area of the air-blowing passage 32 may be considered to decrease the air trunk resistance. However, in this case, the size of the electric heater portion 3 will increase and the wind velocity of the air blasted out of the second outlet 12b will also increase, which poses a problem. To avoid this problem, the air trunk area of the storage portion containing the electric heater 34 has been increased so that the expansion to decrease the influence of the electric heater 34 on the air trunk resistance may be mitigated.

As shown in FIGS. 1 and 3, according to the present embodiment, a metal expansion 35 leading to the second outlet 12b is linked to the downstream end of the air -blowing passage 32to provide the storage portion that contains the electric heater 34. In this case, the air trunk area is increased vertically as against the airflow direction so that the air trunk resistance in the expansion 35 may be roughly the same as that of the air-blowing passage 32 on both sides of the expansion 35. Further, a cross-sectional area of the exit of the expansion 35 is increased compared to that of its entrance. Accordingly, the air trunk resistance of the expansion 35 is decreased and thus air flows smoothly all along the air-blowing passage 32, so that it is unnecessary to increase the rotation speed of the second air-blowing fan 33. This prevents the operating sound from increasing.

Further, it is possible to prevent the overheating of the gas heater portion 2, the case 3, etc., because the distance between the inner wall face 351 of the storage portion 35 and the electric heater 34 can be preserved and the air flowing through a gap between the inner wall face 351 and the vertically positioned sheathed heaters 341 of the electric heater 34 has a cooling effect. Furthermore, only the expansion 35 of the electric heater 34 is

increased in air trunk area, so that it is possible to suppress an increase in the size of the electric heater portion 3.

Although in the present embodiment, as shown in FIGS. 1 and 3, the air trunk area of expansion 35 has been increased in such a manner that its cross section may be rectangular, an inclined face 352 may be formed in the vicinity of the exit of the expansion 35 so that the air trunk area on the downstream side of the expansion 35 is decreased smoothly as shown in FIG. 4. In this case, turbulent flow is prevented from occurring at the expansion 35, so that the air-blowing resistance of air flowing along the inner face of the expansion 35 is decreased, thus further decreasing the air trunk resistance.

If the bent portion 32a is formed on the air-blowing passage 32 and the moving vane 331 is positioned on this bent portion 32a, the cooling effect on the upper side of the expansion 35 deteriorates because the heated air rises and also because the volume of air on the inner side is less than that on the outer side of the bent portion 32a. Thus, the volume of air flowing through the upper side is less than that flowing through the lower side of the electric heater 34. Therefore, the upper side of the expansion 35 is overheated by radiation heat etc. from the electric heater 34, the excess heat of which is stored in the case 31, thereby possibly overheating the gas heater portion 2 and the case 31.

Therefore, as shown in FIG. 5, the electric heater 34 may be displaced downward or, as shown in FIG. 6, the expansion 35 may be formed in such a manner that the distance between the upper inner wall face 351a of the expansion 35 and the electric heater 34 is greater than that between the lower inner wall face 351b of the expansion 35 and the electric heater 34. Accordingly, the distance between the upper side of the expansion portion 35 and the electric heater 34, which is the heat source and with respect to which this expansion portion is positioned to be easily heated by it, is increased to facilitate air flow on the upper side of the expansion 35 and enhance heat insulation for the wall faces and the surrounding area of the expansion 35, thereby preserving the cooling effects and preventing overheating.

It should be noted that, as shown in FIG. 7, a separate heat insulating material 5 may be provided around the expansion 35 to prevent the transfer of heat from the electric heater 34 to the case 31. In this case, an airspace is formed between the heat insulating material 5 and the expansion 35 to provide a double structure, which thereby prevents the heat from being radiated externally.

Further, as shown in FIG. 8, an incurved plate material 6a may be provided on the inner side of the expansion 35 shown in FIGS. 1 and 3 to ensure that the air trunk area at the

expansion portion 35 changes smoothly. In this case, the air trunk area of the expansion 35 increases smoothly from its entrance and decreases from a position somewhere along it toward its exit. Accordingly, it is possible to prevent turbulent flow from occurring at a turning point of the expansion 35, thus further smoothing the air flow.

Further, the incurved plate material 6a, which is provided as described above, causes the expansion 35 to have a double structure and, therefore, itself has a heat blocking effect. An airspace is formed between this plate material 6a and the inner wall face 351 of the expansion 35, which further improves the heat insulating effects. In this case, the incurved plate material 6a may be made of a material having adiathermancy. Thus, it is possible to further suppress the excess heat from spreading to the surrounding area of the expansion 35, which, thereby, prevents the overheating of the gas heater portion 2.

Further, as shown in FIG. 9, a plate material 6b having adiathermancy may be incurved in a V-shape and arranged on the inner side of the expansion 35. In this case, the sheathed heaters 341 are arranged alternately in the air-flow direction to ensure that the air flows smoothly between the sheathed heaters 341.